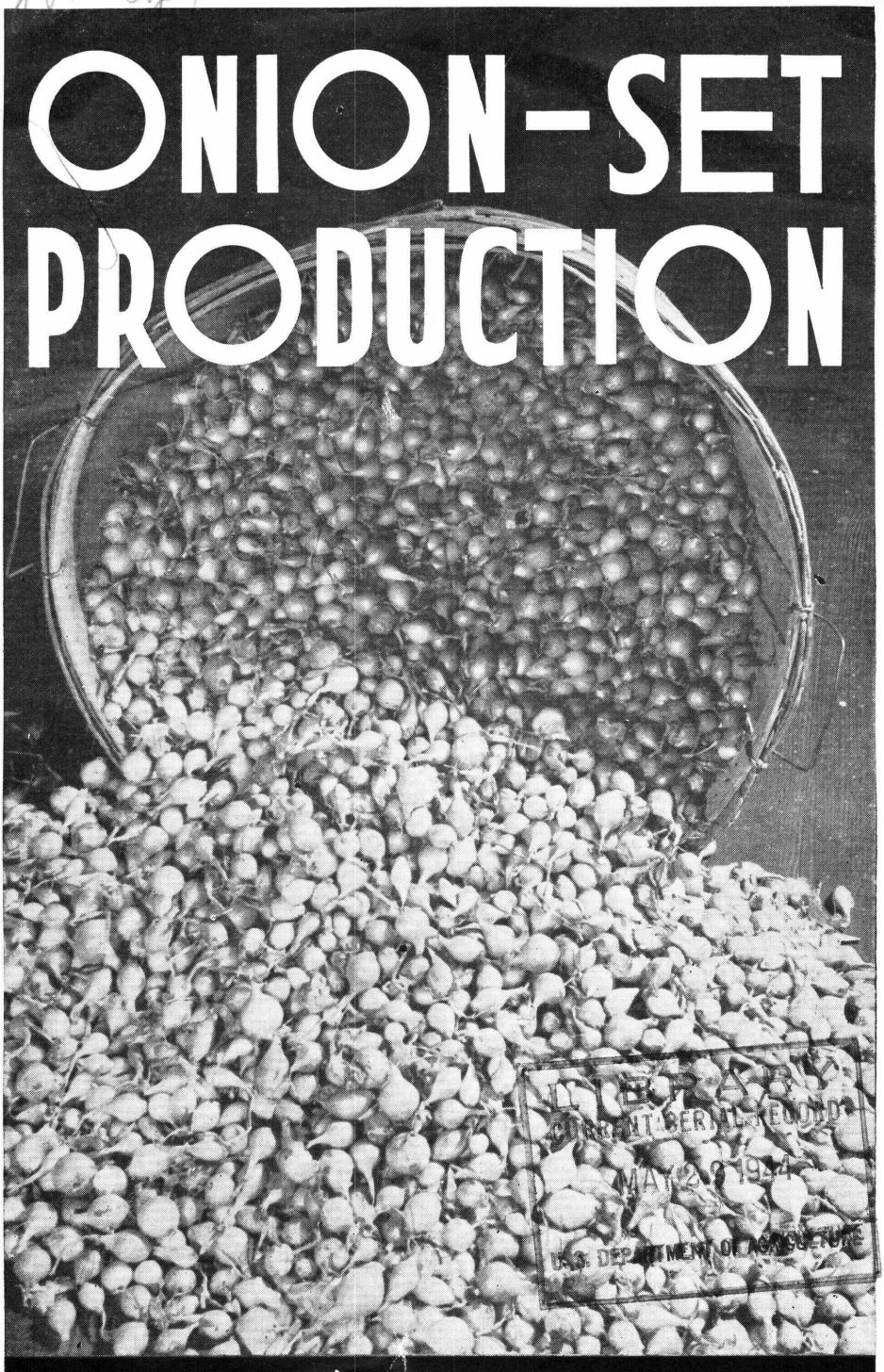
ONION-SET PRODUCTION



FARMERS' BULLETIN NO. 1955
U.S. DEPARTMENT OF AGRICULTURE

A CRITICAL SHORTAGE of green onions for immediate use, as well as of mature bulbs for storage, has developed in the United States. Commercial growers and Victory gardeners are making every effort to meet this emergency. In the North the planting of dry onion sets is the easiest and surest way to produce an onion crop, especially for the amateur. Too few sets are available to meet the present demand, and an effort should be made to provide an adequate supply. The information in this bulletin should help to increase the production of onion sets. The cultural methods used when the set crop is grown under irrigation and under humid conditions are outlined. Attention is also given to insect and disease control and to harvesting, curing, storing, and processing the sets.

This bulletin supersedes the sections on onion sets in Farmers' Bulletin 434, The Home Production of Onion Seed and Sets.

Washington, D. C. Issued May 1944

ONION-SET PRODUCTION

By J. C. WALKER, *professor of plant pathology, University of Wisconsin,* and *agent, Division of Fruit and Vegetable Crops and Diseases;* and W. C. EDMUNDSON, *horticulturist,* and H. A. JONES, *principal olericulturist, Division of Fruit and Vegetable Crops and Diseases, Bureau of Plant Industry, Soils, and Agricultural Engineering, Agricultural Research Administration*

Contents

GROWING ONIONS FROM SETS is the surest and easiest method of producing green onions and large bulbs in many districts. The term "set" is applied to a small onion bulb, usually less than an inch in diameter, used for propagation.

In the trade two types of sets are known. One type is called top sets, or top onions. They are bulblets produced at the top of the seed stem of some types of onions in the position usually occupied by the flowers and later by the seed. Top sets are the principal means of propagating the Egyptian winter onion. They are used mostly in home gardens in the North for the production of early green onions. The other type is known as bottom sets. Bottom sets are grown from seed sown thickly enough to produce only stunted bulbs. After being cured, these diminutive bulbs can be stored for long periods and used to produce green onions or mature bulbs. Since top sets are relatively uncommon and since between 1 and 2 million bushels of bottom sets are used annually in the United States, the latter, as is customary, will be called sets in this bulletin.

The chief advantages of growing green onions and large bulbs from sets are that growth is made early, so that the crop matures before blast or thrips cause much injury; and, being immune to smut, sets can be grown in infected soils without fear of loss from this disease. To some extent northern-grown sets are shipped to the Southern States in the autumn for immediate planting for green onions or for early-spring bulbs. For the home gardener especially, use of the onion sets is a much surer means of obtaining a satisfactory crop. The early maturity of the crop spreads the labor of harvesting over a longer period in some parts of the country. During the present emergency, when maximum yields are desired and labor for harvesting is short, it is important that an adequate supply of sets be available at a reasonable cost.

PRODUCTION DISTRICTS

Sets are produced in relatively few districts. Chief of these is the Chicago district, extending from Lake County, Ind., through Cook County, Ill., to the south, west, and north of the city and into southeastern Wisconsin. Important also are the Greeley district of Colorado and the Willamette Valley of Oregon. Relatively small quantities are grown for local use in the Connecticut River Valley of Massachusetts; near Chillicothe, Ohio; Louisville, Ky.; and Canastota, N. Y., and north of Davenport in eastern Iowa.

Production in the Greeley district is under irrigation. Methods described for this district are generally suitable for other production districts of the West where the crop is grown under irrigation. In the Middle West and in the East rainfall is usually ample for set production, though supplemental irrigation may occasionally be practiced. Methods described for the Chicago district will apply generally to production under humid conditions.

SUITABLE SOILS

Although in recent years the production of large bulbs in the North has shifted largely from mineral to muck soils, such has not generally been the case in the production of onion sets. They are still produced most satisfactorily on mineral soils. River-bottom, old lake-bottom, or deep black prairie soils are favored over heavy clay or light sandy soils. Muck soils tend to produce plants with heavy tops and thick necks, adding to the task of curing and not enhancing the keeping quality.

Perhaps the secret of success on well-drained river-bottom or lake-bottom soils is that they are fairly high in water-retentive characteristics but still friable enough not to be easily waterlogged. If a soil dries out rapidly in midsummer it may cause the set crop to mature before the bulbs are large enough, leaving too many culls and greatly reducing yields. The good onion-set soils south of Chicago, in southeastern Wisconsin, and in Madison County, N. Y., are to a considerable extent old glacial lake-bottom soils. They are usually very flat, and drainage is often provided by planting in long, narrow, raised beds.

In the Greeley district, where onion sets are grown under irrigation, most of the crop is produced on medium heavy soil, although sandy loam is also considered satisfactory. A sandy soil requires very frequent irrigation, and the walls of the beds are inclined to crumble. The slope of the ground is considered important. If there is too much slope the ditch will wash, leaving the beds high and difficult to irrigate. A drop of 1½ feet for 500 to 600 feet of slope allows a slow flow of water and is considered ideal for the growing of onion sets.

ROTATION

Often the cost of weeding onion sets leads to a short rotation or to continuous culture, as is so commonly the case with large-bulb production. In the Greely district most growers follow a 4- to 6-year rotation. Some growers plant grain 1 year, alfalfa 2 years, beans or melons

1 year, and onion seed for set production for 2 years. Onion seed for sets is seldom planted after alfalfa, because of the difficulty experienced with alfalfa roots.

FERTILIZATION BEFORE PLANTING

A high plane of fertility is necessary, but avoidance of too much nitrogen is desirable so as to discourage excessive growth. Set growers usually can judge from experience the best formula and amount of fertilizer to use. In the Canastota district of New York one-half to three-quarters ton of 3–12–18 fertilizer is used. Soil tests can now be readily obtained usually from fertilizer company laboratories, from county agents, or from State experiment stations. Barnyard manure may be used, but it should be well rotted so that it will not attract flies of the onion maggot or cause drying of the soil.

PREPARATION OF THE SOIL

Since onion seedlings are very easily injured in the early stage of growth by adverse weather and by tight, baked soil, they must be handled very carefully to produce a profitable stand. Uneven stands result in oversize bulbs, which are worthless as sets. It is therefore necessary to prepare as perfect a seedbed as possible.

Land for sets is usually fall-plowed. In preparation for planting, soil should be handled so as to prevent lumping. In most districts the land is first thoroughly disked and harrowed; then it is pulverized and smoothed with a Meeker harrow to put the surface in final shape for sowing. In the Greeley district, land is prepared by leveling it with a float (fig. 1), then plowing furrows 28 inches apart, and smoothing the ridges (fig. 2). The bed is 20 inches across the top, and the ditches are about 4½ inches deep.

Under irrigation the soil should be slightly moist when the beds are being made, so they will be firm and well shaped. If the soil is dry the sides of the bed will crumble; if too wet, the soil will pack. Two beds are constructed at one time. After the first two beds are made, the outside shoe, or runner, follows in the outside furrow so that the furrows will be the same distance apart.

SOWING THE SEED

In most districts sowing is done as early in the spring as the seedbed can be prepared properly. In the Chicago district this may occur occasionally in late March, but usually the planting season extends from mid-April into early May. In the Greeley district most seeding is done between April 15 and May 15; however, later planting is sometimes necessary when growers do not have access to an early supply of irrigation water.

The germinative capacity of the seed should be determined in advance and the rate of sowing adjusted accordingly. In the Chicago district the rate of seeding has usually been 60 to 80 pounds per acre; sometimes it is as low as 50 pounds. In the Greeley district 80 to 100 pounds are used. These rates are 20 to 30 times those used for large bulbs. The purpose of this heavy seeding is to force the plants to

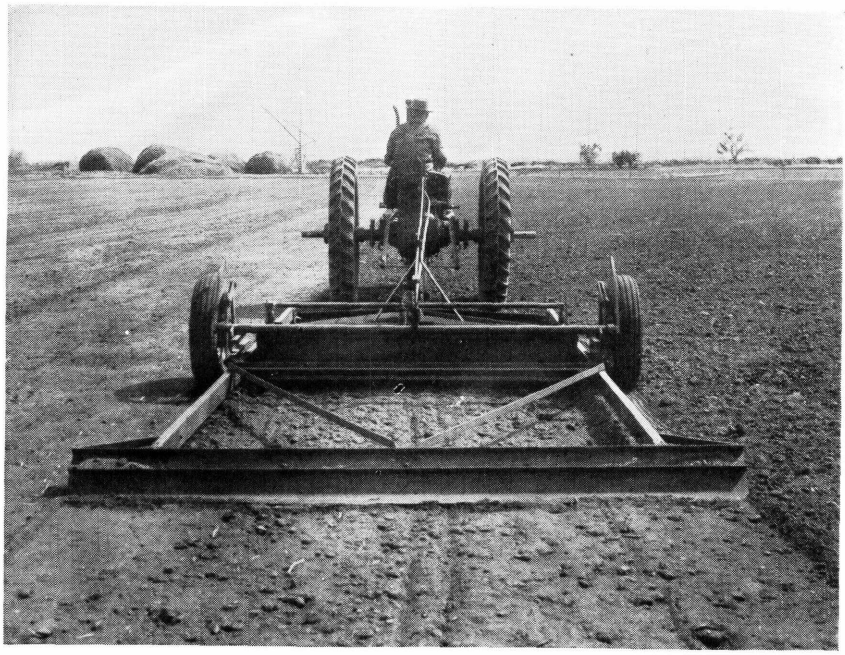
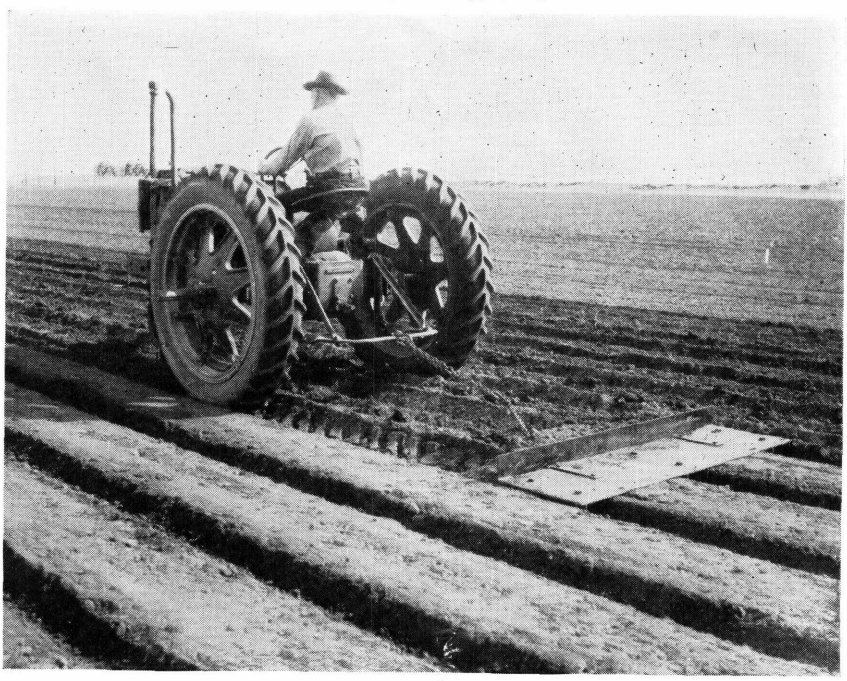


FIGURE 1.—Leveling the land preparatory to making the beds, Greeley, Colo.

FIGURE 2.—Smoothing the tops of the ridges preparatory to planting onion seed for sets, Greeley, Colo.



grow in a very crowded condition to reduce the normal size of the bulbs. The competition for soil moisture and nutrients stunts the plants and hastens maturity by 3 weeks or more. The ideal set is slightly less than an inch in diameter. Even seeding and uniform stands are very essential for production of sets of desirable size. When the stand is thin or uneven, oversize sets are produced. These are practically a total loss, since they are of no value as sets and are too small for table stock.

Several methods of seeding have been used. In Ohio and Oregon a multiple-row seeder has been employed; six to eight furrows about an inch apart are thus sown simultaneously. In the Greeley district, where the seed is sown on beds, specially built planters are used (fig. 3). These consist of two seeders attached to a small garden tractor, so arranged that if one is forced out of the ground by clods of earth the other stays in. The planter shoes are made by extending the common 4-inch type to a 6-inch width in order to make a wider furrow. The seed is allowed to fall on a plate near the bottom of the furrow in order to distribute it fanwise in a band 4 to 5 inches wide and at a depth of ¾ of an inch to 1 inch, or sometimes a little deeper. The drills are set to leave about 6 inches between rows, and a shut-off is arranged so that the flow of seed can be stopped from both seeders at the same time. Four-row drills have also been adapted to this method of sowing.

The systems just described are devised to provide rows 6 to 8 inches wide in which the seedlings are well distributed but still close enough together to arrest growth at the stage of small-bulb formation. When

FIGURE 3.—Planting onion seed for sets on raised beds, Greeley, Colo.

onion smut is prevalent and a formaldehyde solution must be applied in the furrow with the seed these methods have not been found to be practical.

Since smut prevails generally in the Chicago district another seeding method is used. The seed is sown thickly in a narrow furrow in rows 12 to 14 inches apart with the same equipment and in the same manner as for large-bulb production. Six-row gang seeders (fig. 4) are commonly used, and cultivation is carried out by three-row, walking, motor-driven cultivators. Three-row seeders are also common (fig. 5). Large riding cultivators, taking six rows at a time, are used to some extent, but they are not so well adapted to the narrow distance between rows.

CULTIVATION AND WEEDING

Early cultivation is essential. The crust that forms on the surface of the soil after rains or irrigations at the time the plants are emerging, or when they are small, should be broken as soon as possible with a minimum of injury to the plants. Tools for breaking the crust are mostly home-made. Most growers use light wooden rollers covered with galvanized iron into which nails have been driven and the heads removed (fig. 6). Rollers may be constructed to break the crust over one or more rows. Some growers use light rakes with long handles made by driving eightpenny box nails into strips of wood about three-fourths of an inch thick and wide enough to cover one or two rows. A long, light handle is then attached to the rake head. Under irrigation, water is often applied to prevent the formation of a crust at the time the plants emerge from the soil. This eliminates the work of breaking the crust by mechanical means.

FIGURE 4.—Six-row onion seeder with formaldehyde-drip attachment.

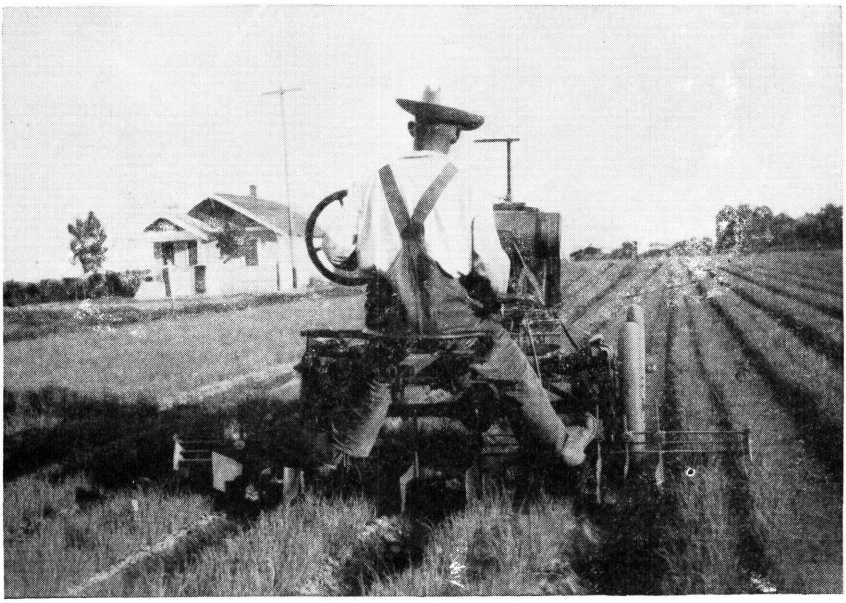
FIGURE 5.—Three-row onion seeder with formaldehyde-drip attachment. The tractor is used for cultivating after a three- or six-row seeder.

The successful grower kills as many weeds as possible before the seed is sown. Selection of clean land, fall disking or plowing and disking, good spring tillage, and prompt cultivation help to keep weeds under control. Cultivation for weed control is done with shallow knives set to cut close to the row and not injure the young plants (fig. 7). Cultivation should be shallow at first and increase in depth only slightly as the season advances. It should be done every week or 10 days, or often enough to kill weeds while they are still small. Under irrigation, cultivations are very shallow, and care is taken not to disturb the sides of the beds. Knives are used to just skim the surface. Very shallow cultivations are sometimes made to form a slight soil mulch.

Weeding in the row must be done by hand and is necessarily the most expensive operation in set production. In the Chicago district three weedings are usually necessary; obviously the promptness and thoroughness with which each is done are large factors in determining the cost of succeeding ones. Under irrigation the fields are usually weeded three to five times. If the soil contains a fair amount of moisture the weeds pull easily, but if it hard a small metal weeder is used.

FIGURE 6.—Breaking the crust over the rows so that onion seedlings can emerge from the soil, Greeley, Colo.

FIGURE 7.—Four-row onion cultivator, Greeley, Colo.



IRRIGATION

In the Greeley district the first irrigation is generally given very soon after planting, especially if seeding was done in dry soil (fig. 8). Water is often applied a second or even a third time before emergence of the plants to provide moisture for the young seedlings until they become well established.

Onion sets require frequent irrigation to maintain a uniform vigorous growth (fig. 9). The length of time between irrigations depends somewhat on the water-holding capacity of the soil. Some of the sandy or gravelly soils require irrigation every 3 or 4 days, whereas on the more retentive heavy soils 6- or 7-day intervals may be sufficient.

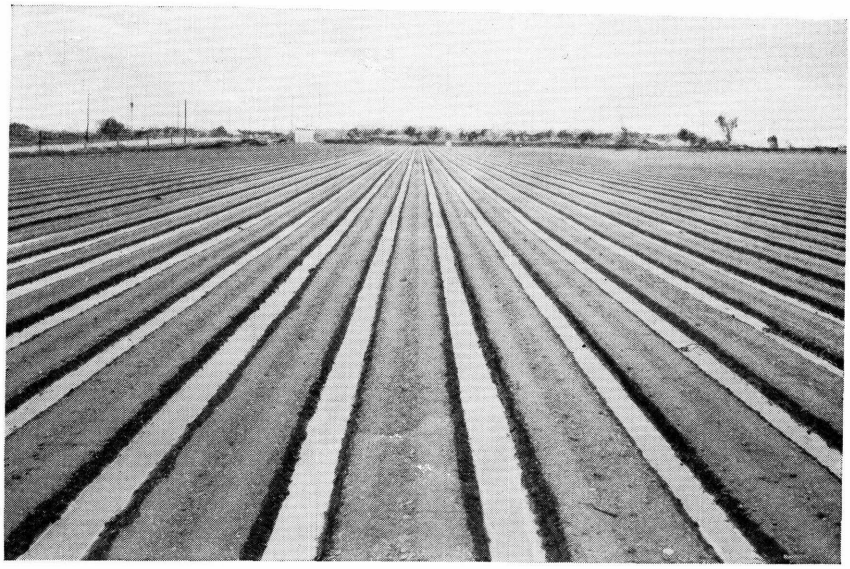


FIGURE 8.—Applying water after seeding, Greeley, Colo.

FERTILIZING THE GROWING CROP

In the Greeley district the growers apply a side dressing of commercial fertilizer, usually ammonium sulfate, during the growing season. The first application is generally made about the time the plants start to bulb. Some growers make but one application; others make two or three if the plants seem to require it. Ammonium sulfate is generally added at the rate of 150 pounds an acre per application, although some growers use 200 pounds. The fertilizer is usually applied in narrow bands about half way up the side of the bed. Home-made distributors are generally used; they consist of two cans of about 1-gallon size fastened to a handle. Holes three-eighths of an inch in diameter are made in the bottoms of the cans to distribute the fertilizer in the proper place. Some growers make one application in the strip of soil between the rows on the bed by means of a small seed drill. It is essential that the fertilizer be well dried in order to flow freely through the small openings in the distributor.

FIGURE 9.—Applying water to the growing crop, Greeley, Colo.

As soon as possible after the fertilizer is added to the sides of the bed, it is covered with a thin layer of soil by running ditchers in the furrows. A small head of irrigation water is then used in each furrow to leach the fertilizer into the soil about the roots. The head of water is kept small to prevent the fertilizer from being washed down the furrow to the lower end of the field or from being lost in the runoff water. When fertilizer is applied between the rows of sets on the bed, the water is kept running in the furrows until the center of the bed is moist. In the Canastota district if the season is wet and the onion tops turn a little yellow, a side dressing of nitrate may be applied.

HARVESTING AND CURING

In the Chicago district the stage at which sets are harvested varies somewhat. A crop sown in April is usually harvested in mid-July. In some localities the sets are pulled when the tops are still green but, in general, harvesting occurs when the tops are yellow and dropping over. The first operation is to cut the roots. This is done by attaching to the cultivating equipment a cutting blade which runs beneath the row. Pulling and crating are done by hand. Ordinarily the tops are not cut but rather twisted off as the bulbs are placed in baskets. A preliminary screening is done at this time to remove soil. The sets are then placed in shallow crates made from rough 1-inch lumber with standard 4-foot lath spaced three-eighths of an inch apart on the bottom (fig. 10). The crates are usually 4 inches deep, 2 feet wide,

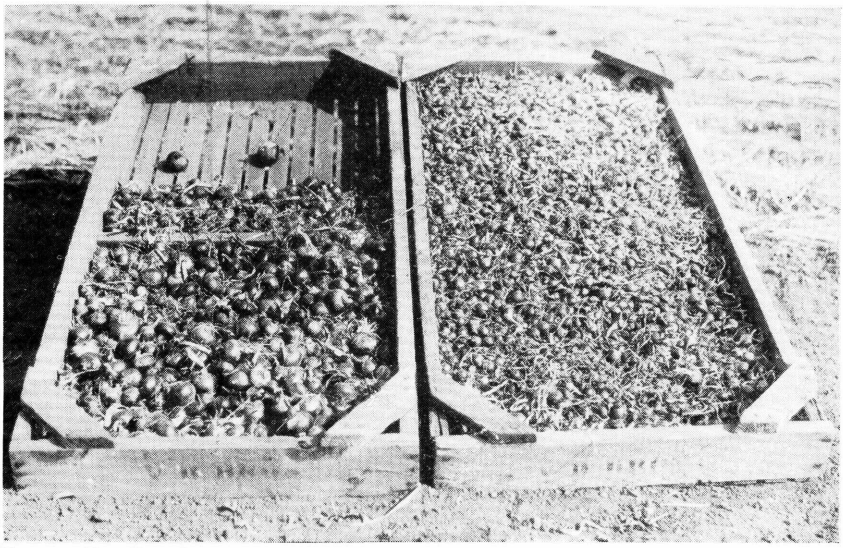
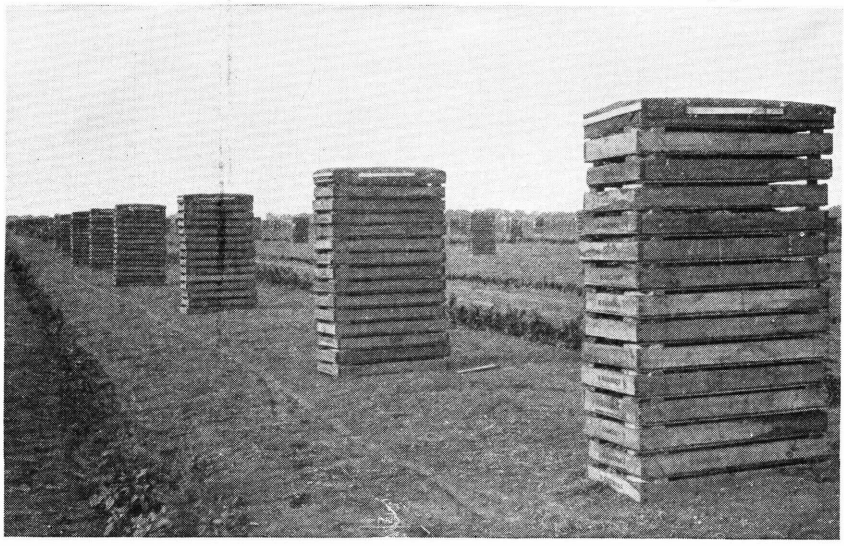


FIGURE 10.—Standard crate used for curing and storing onion sets in the Chicago district.

and 4 feet long. Cleats nailed across the upper corners serve as handles for lifting the crate and also provide an air space between crates when they are stacked in tiers; 2-inch boards are best for the cleats, but 1-inch material is also used. The crates hold slightly more than a bushel of sets.

It is highly important to cure sets promptly. This is the reason for the shallow crates. The best place for fall curing is in the field,

FIGURE 11.—Crates of onion sets properly stacked, with provision for ventilation, Lansing, Ill. Note that the top trays are covered with tar paper.



where (fig. 11) crates can be stacked in tiers of 12 or more; each tier is covered with roofing paper. Ordinarily sets in good condition may remain in the field to cure for 6 to 8 weeks, but during this time they should be carefully watched. Neck rot and premature sprouting may occur, particularly if the sets have been harvested during wet weather and if unusually high humidity and heavy rainfall prevail during the curing season. If considerable rot occurs, it may be necessary to take the sets to the warehouse early to rescreen them and remove diseased and sprouted bulbs.

In the Canastota district the plants are pulled when the bulbs have reached the proper size. Two rows are pulled at a time and left in windrows with the tops covering the bulbs. They are left this way to cure for 2 or 3 weeks or until the tops have thoroughly dried. If the soil is particularly hard the crop may be loosened before being pulled by running a celery cutter beneath the row.

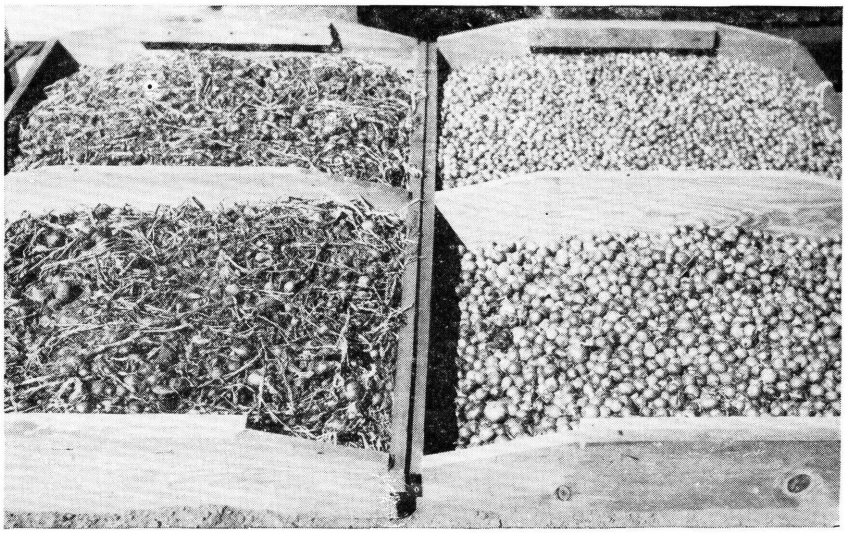
In the Greeley district the sets are harvested just before the tops start to break down. This is done to facilitate handling, as dry tops make harvesting difficult. A cutting machine with a knife that extends across the bed cuts the roots slightly below the bulbs (fig. 12). The depth is generally controlled by a roller which runs along the bed and holds the cutting blade at a uniform depth. Most growers cut but one bed at a time. The sets are picked up by the tops and placed

FIGURE 12.—Harvesting onion sets with a two-bed machine, Greeley, Colo.

FIGURE 13.—Placing onion-set plants with tops on in trays to dry, Greeley, Colo.

in trays (fig. 13). These are 4 feet long and 2½ feet wide, with end walls 6 inches high at the center and tapering to the side walls, which are 3 inches high. The trays are provided with a center partition. A handle, consisting of a 1½- by ¾-inch board, is nailed to the inside of each end to facilitate moving the crates and to provide a better surface for stacking (fig. 14).

FIGURE 14.—Standard crate used for curing and storing onions in the Greeley district.



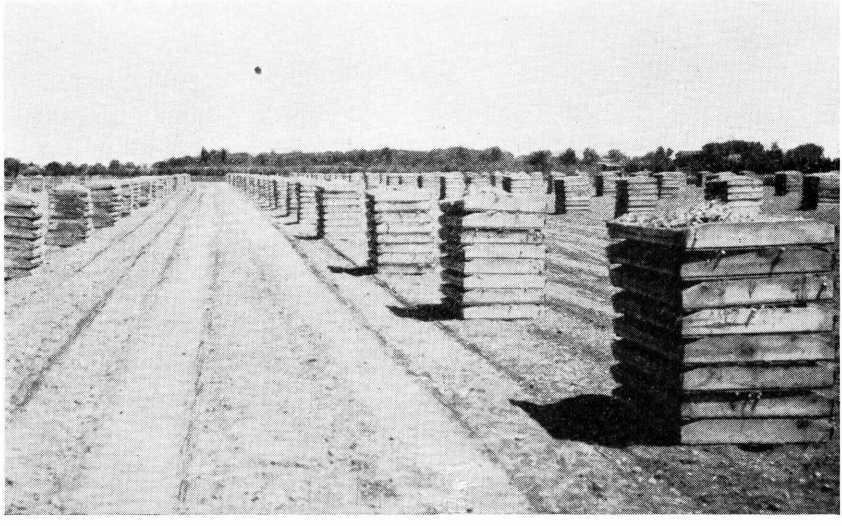
The trays are completely filled with sets and stacked seven to eight high (fig. 15). Some growers cover the top tray, but usually this is not done. The sets are thus left in the field to cure for 4 to 8 weeks. When dry, the tops are rubbed off. This is generally done on a sloping table with a screen bottom having a ¼- or $\frac{5}{16}$-inch mesh. The rubbing table is generally 12 to 14 feet long and 2 feet wide. Some growers do the rubbing in the trays, and some use a motor-driven rotary drum to remove the tops. The field cleaning and rubbing remove most of the dried tops and the dirt. The sets are then placed in storage.

An abundance of bright sunny weather and of natural aeration is usually sufficient to put sets in good condition for storage. Occasionally, however, when abnormally heavy rainfall and high humidity prevail during the last 3 weeks before harvest and continue more or less intermittently during harvest, sets do not mature properly and the neck tissues are abnormally succulent at harvest. If humid, cloudy, or rainy weather continues, neck rot gets under way, and premature sprouting is usually heavy. The white varieties are very susceptible to neck rot and smudge, and they are severely damaged under these circumstances.

Artificial curing has been used commercially in a limited way for White Portugal sets and may be accomplished in various ways. One way is to force through the crates air which has been dried and heated to 100° to 120° F. by being passed over steam coils (fig. 16). Some onion-set warehouses are equipped with such facilities.

In Oregon, sets are commonly cured in hop driers, but ordinarily this is done at the end of the storage period. A drier in an onion warehouse is a valuable asset, since it can be used to get poorly cured sets in proper condition for storage. Also, it may be useful at shipping time, because sets that become moist during storage are difficult to handle in the cleaning equipment, and a few hours of drying puts them in ideal

FIGURE 15.—Onion trays filled with sets stacked in the field to cure, Greeley, Colo.



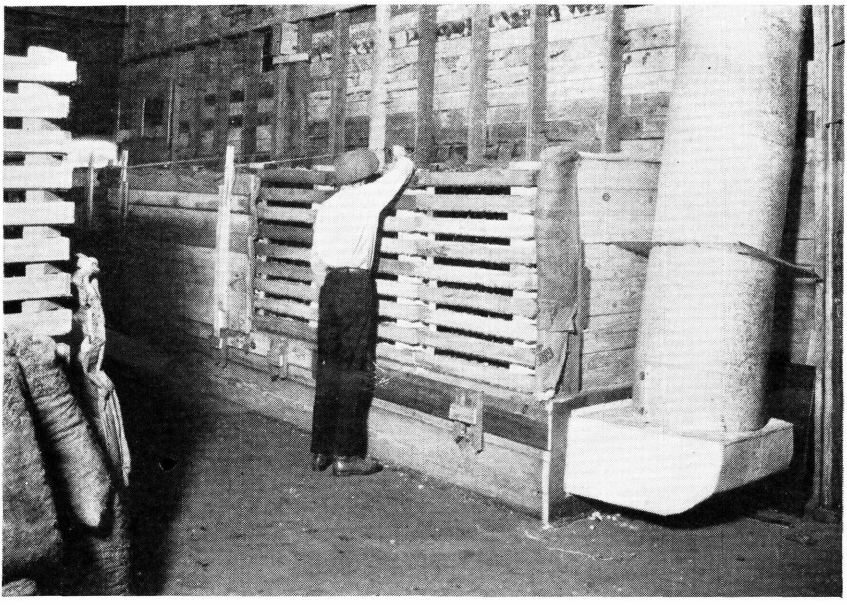


FIGURE 16.—Onion-set drier in a commercial warehouse. Warm air is blown into a chamber below the crates and forced through the sets. The sides of the tier are sealed by padded removable side frames to prevent the warm air from escaping except through the top. One side has been removed so that the sets may be examined.

shape for processing. The cost of drying is offset by the labor and power saved in preparing the sets for shipment.

Drying equipment should be so installed that the building is not endangered by fire.

YIELDS

The yield of onion sets is from 400 to 500 bushels per acre in the Greeley district. In the Chicago district yields average about the same; however, they sometimes are as high as 800 bushels per acre.

STORAGE

Sets are usually stored in or near the production district and, except for a small percentage shipped to the South for autumn planting, are conditioned, packaged, and distributed to retail stores and to market gardeners during late winter and early spring.

In the Northern States when the sets are cured they are moved in crates to an insulated warehouse and stored without artificial refrigeration. During fair autumn weather, doors are left open during the day; thus every opportunity is provided for the moisture given off by the sets to evaporate. Doors are usually closed at night and during rainy weather. The temperature of the warehouse drops gradually with that of the outside atmosphere until it reaches 32° to 35° F.; then every effort is made to maintain this temperature. Ventilation through

roof vents should be provided, and the relative humidity should be kept below 90 percent. Doors are opened during bright clear days if the temperature is not too low. Thus, a skillful operator can store a set crop until February or March with a minimum of operation cost and shrinkage.

Forced circulation is not necessary if the warehouse is well built and vents are provided along the floor and in the peak of the roof. During zero weather it may be necessary to provide some heat, but this is kept to a minimum. Heating may be done by a central system of hot water or steam or by stoves placed in the aisle between the tiers of crates.

In the Greeley district most of the storage houses have drop siding nailed to 2- by 6-inch studs with sheeting on the inside. Some houses have a layer of insulating material next to the sheeting. The inside of the wall is generally filled with dried onion tops for insulation. The ceiling above the storage room is also covered with onion litter.

The sets are placed in storage immediately after the field cleaning. About 1½ bushels of sets are placed in each tray, and these are generally stacked 14 to 18 high in some houses nearly to the ceiling (fig. 17). In the larger houses 3 tiers of trays are placed together, with a space of 18 inches between stacks to afford proper circulation of air and a 16- to 18-inch space between the wall and the outside stacks of trays. The method of stacking depends somewhat on the dimensions of the storage room.

Ventilators are generally spaced along the outside walls of the storage house to allow the intake of air when necessary. The large outside doors are opened when a rapid change of air is desired, as shown in figure 17. The low humidity of the Greeley district is very favorable for the curing and storing of onion sets.

In the Canastota district if the grower intends to sell his crop in late summer or fall he may rub the bulbs over a screen to clean and grade them; then he places them in jute bags. If sets are to be kept and planted, the cleaning and grading may not be done until the following March. Storing is usually done in 16- by 24-inch crates 4 or 5 inches deep. These are placed in common storage (without artificial refrigeration) and provided with good aeration.

PROCESSING FOR DISTRIBUTION

Before being distributed, sets are taken from the crates and run through a fanning mill that removes loose scales, dust, and withered sets. They are then run over a moving belt with workmen on each side to remove clods and partly rotted and sprouted sets. After being hand-picked, the sets are graded. The maximum diameter is usually specified and may range from $^{15}/_{16}$ to 1½ inches. These diameters also may be specified as bar or screen. Thus a $^{15}/_{16}$-inch bar means that when final grading is done, the sets that are packaged are those which drop through a slatted grader in which the bars are $^{15}/_{16}$ of an inch apart. A $^{15}/_{16}$-inch-screen grade refers to those sets passing through a screen the mesh of which has a $^{15}/_{16}$-inch square opening.

More of the oblong bulbs with a minimum $^{15}/_{16}$-inch diameter will go through a bar grader than through a screen grader. This

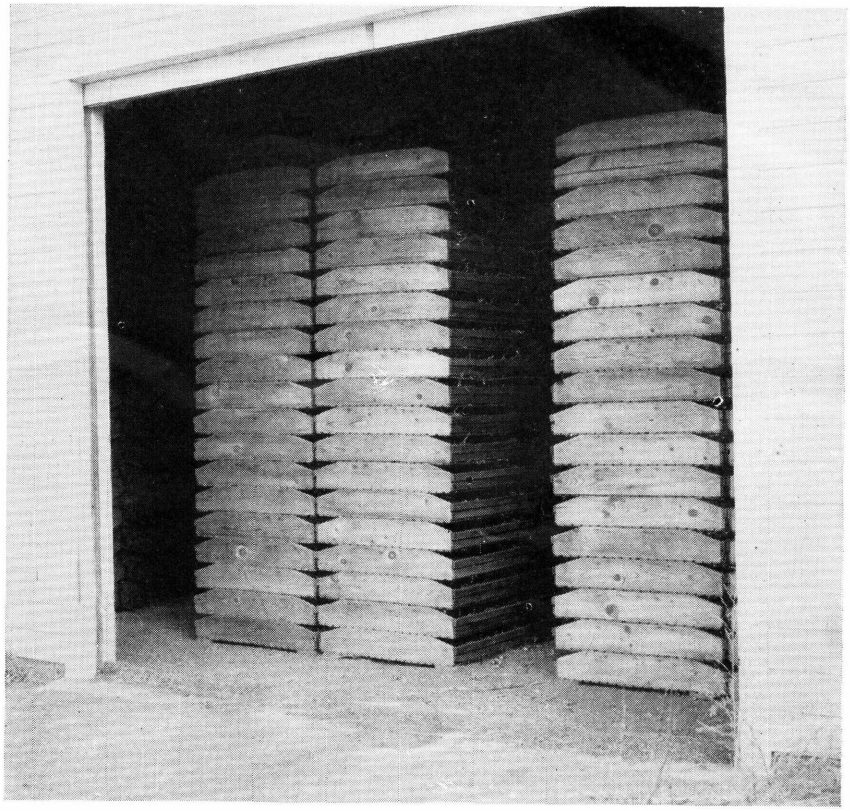


FIGURE 17.—Method of stacking trays in storage, Greeley, Colo.

method of culling does not always give a true picture of the size of the sets. Those described as having passed through a $^{15}/_{16}$-inch bar screen may actually have a considerable percentage ranging from 1 inch up to 1¼ inches or more in diameter if the onions are flat-shaped. If the field run of sets is generally small there may be practically none over 1 inch in diameter after having passed through the $^{15}/_{16}$-inch bar screen.

To eliminate some of the difficulties and misunderstandings inherent in this type of grading, the United States Department of Agriculture has established U. S. standards for onion sets; the actual size of the set rather than the size of the screen is the basis for the size grade. Detailed specifications relative to the various grades can be obtained upon request from the Office of Distribution, War Food Administration, Washington 25, D. C.

Processed sets are usually packed in 1-bushel open-mesh sacks. A standard weight of 40 pounds per bushel is used at harvest, but for the processed set ready for market the standard is 32 pounds per bushel. Sets are distributed largely through retail seed houses and groceries. Growers and contractors usually sell to jobbers who, in turn, distribute within a certain radius to retail outlets.

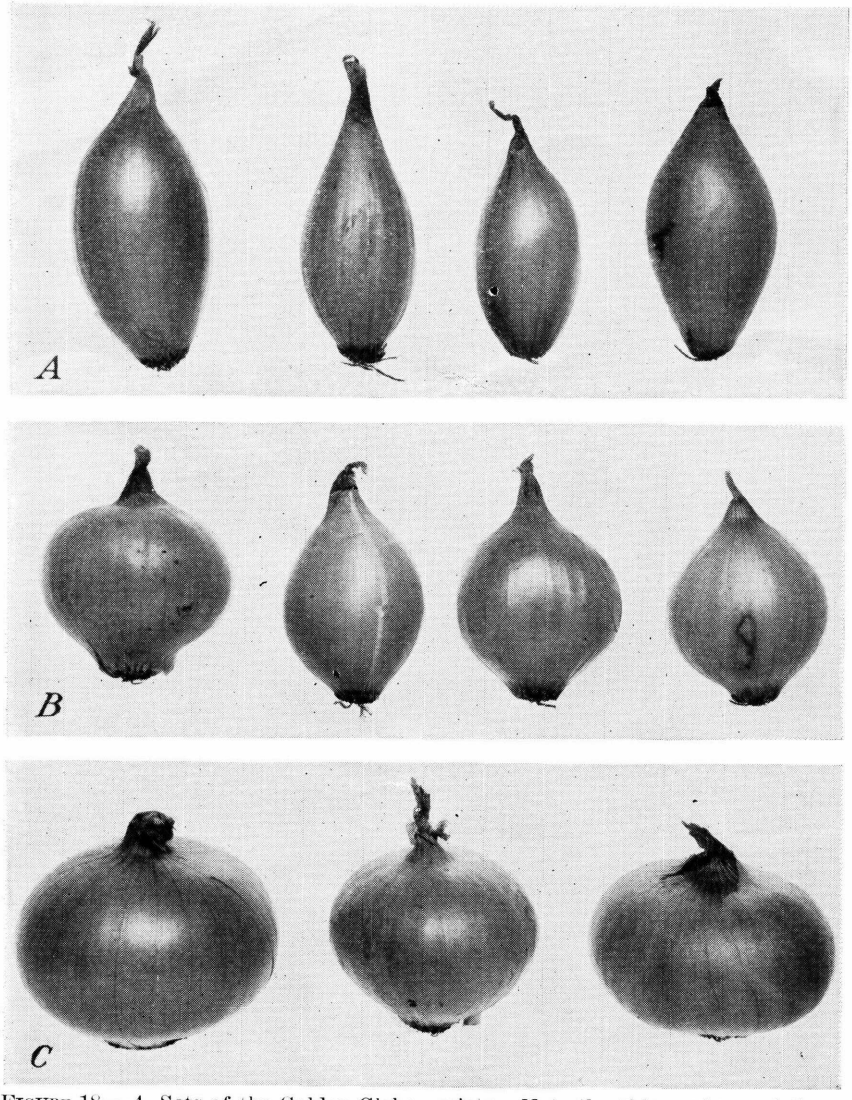


FIGURE 18.—*A*, Sets of the Golden Globe variety. Note the oblong shape of these sets. *B*, Sets of the Ebenezer, a flat-bulb variety. Note that the sets are nearly spherical. *C*, Oversize bulbs from the same lot as *B*. These bulbs grew to a larger size than the sets and took the typical shape of the variety.

VARIETIES

Bulbs of commercial sets are of three colors, yellow, white, and red; the commercial volume of yellow bulbs is much greater than that of white and red combined. Most of the sets are of varieties that have flat or oblate bulbs when allowed to grow to normal size; but when crowded, they produce sets that are spherical or nearly so. Likewise, when globe-shaped onions are grown as sets the bulbs take on a dis-

tinctly oblong shape (fig. 18). Perhaps one reason why so few globe-shaped onions are grown as sets is that the flat types produce the most attractive globular sets.

The most widely grown yellow variety is Ebenezer. A limited quantity of the yellow globe type is grown on special order. The white sets are almost exclusively White Portugal, and the red sets are usually Red Wethersfield.

DISEASES AND THEIR CONTROL

The chief diseases encountered in growing sets are smut, smudge, neck rot, fusarium rot, pink root, and yellow dwarf. These are described in detail in United States Department of Agriculture Farmers' Bulletin 1060, Onion Diseases and Their Control.

Onion smut remains indefinitely in the soil, and with close cropping most northern onion soils become more or less infested. Satisfactory control is obtained when a stream of formaldehyde is run into the furrow with the seed (figs. 4 and 5). The vapor of the formaldehyde permeates the soil in the area between the seed and the soil surface sufficiently to disinfect it temporarily insofar as smut is concerned. The disinfectant is introduced into the furrow just after the seed is dropped and before the furrow is covered. A pint of 40-percent formaldehyde to 8 gallons of water at 100 gallons per acre is satisfactory, but a slightly better average result may be expected if the solution is made half strength (1 pint to 16 gallons) and twice as much liquid is applied (200 gallons per acre).

The operator should avoid spilling the solution on hands or clothing, as it may cause severe irritation of the skin. Unless a gas mask is worn, mixing should be done only in the open air.

There is no specific control for fusarium rot or pink root. If soil becomes so infested with the organisms that cause these diseases that damage is serious, it should not be used for several years for growing onion sets.

White varieties are much more susceptible to smudge and neck rot than are yellow and red ones. Therefore, particular attention should be paid to prompt and adequate curing of white sets. They should be examined regularly during the curing and storing period. Smudge causes minor shrinkage, but neck rot, once started, may result in rapid decay of most of the crop. When weather conditions are very favorable for neck rot, artificial curing may be resorted to for white sets, as described on page 14. (See fig. 16.)

Yellow dwarf is a virus disease transmitted from plant to plant by aphids and carried over from season to season in bulbs or sets. If the set crop is grown adjacent to bulbs carried over from the previous year for seed production they may be contaminated from such a source. Likewise, an early bulb crop grown from sets may be a source of the virus. Therefore, it is not well to grow sets in proximity to a crop started from sets or next to seed onions. Some years ago such procedure led to a very severe build-up of yellow dwarf in one area in the United States. Isolation of the set crop from other onion crops corrected the difficulty. The minimum isolation distance has not been determined, but 20 rods should be reasonably safe.

INSECTS AND THEIR CONTROL

THRIPS

Thrips are the most destructive insects on onions planted for sets. The amount of damage varies from season to season, but some injury occurs practically every year in many areas. In the South this insect lives on the onion crop throughout the winter. In the North onion thrips pass the winter on bulbs in storage, on onion plants which survive in the field, and on hardy plants. The female lays her small whitish eggs in the tissue of the onion leaf. Under high-temperature conditions the eggs hatch in about 5 days; under cool conditions it takes somewhat longer. The small white larvae feed on the center leaves, where the tissue is tender and where they are well protected. In about 5 days the larvae attain full size, leave the plants, and drop to the soil, where pupation occurs. The pupal stage lasts about 4 days under warm and somewhat longer under cool conditions. Thus a complete generation extends over about 2 weeks, depending upon the temperature. If the growing season is warm more generations will occur than if it is cool.

Environmental conditions during certain seasons may hold thrips damage to a minimum. Cool weather reduces the number of generations; hard, driving rains wash the thrips from the plants and destroy many of them. Predatory insects also aid in reducing infestations.

No entirely satisfactory commercial control of the onion thrips has yet been developed. While this insect is readily killed by contact insecticides such as nicotine, it is necessary that the spray come in direct contact with the pest; this is not readily accomplished by field spraying because many of the thrips are well protected by the onion leaves; furthermore, these sprays do not affect the eggs imbedded in the onion leaf and the pupae found in the soil around the onion plants. In recent experiments on the control of the onion thrips, contact insecticides have proved to be less effective than a poisonous spray containing a sweetening agent. The most effective spray of this character contains 2 pounds of tartar emetic, 4 pounds of granulated sugar mixed with 100 gallons of water, or 2 teaspoonfuls of tartar emetic, 2½ tablespoonfuls of sugar, and 1 gallon of water. In order that the spray may be effective, it is necessary to cover the foliage with a fine mist, using about 125 gallons of the mixture to the acre. The material should be applied before the thrips become abundant and the application repeated at approximately weekly intervals throughout the growing period of the crop.

Tartar emetic is a stomach poison to man and warm-blooded animals and therefore should be handled with care. For this reason its use on onions grown for the green market is not to be recommended. Tartar emetic when ingested even in very small quantities causes serious gastric disturbances. The undiluted chemical must be handled carefully. Use care in storage of both the undiluted chemical and the spray. Vessels used in mixing should be thoroughly cleaned before being used for any other purposes; all surplus spray should be disposed of in such a way that animals cannot come in contact with it.

MAGGOT

The larval form of the onion maggot is white and up to one-third inch in length. It eats its ways into the base of the leaves beneath the soil line, causing them to wilt and die. This type of damage may cause excessive thinning of sets and result in many oversize bulbs.

The insect lives over as brown puparia in the soil or in piles of cull onions. In the spring, these give rise to adult flies, which lay eggs at the base of the plants or in cracks in the soil. The eggs hatch into larvae within a week. These crawl into the soil and chew their way into the plant. They pupate when full grown, and about 3 weeks later another brood of flies may follow. It is usually the first brood which is most damaging to onion sets.

In dry years onion maggots are usually scarce in the Chicago district. They are likely to build up in number after a succession of several wet springs. Their appearance in sufficient numbers to cause severe damage is so spasmodic that regular control measures have not been adopted. It is a worth-while measure, however, to keep all refuse and piles of cull onions removed from around warehouses and onion land. Some control has been obtained by spraying three to five times at weekly intervals, beginning when plants are an inch high. Three gallons of lubricating-oil stock emulsion added to 97 gallons of 8-12-100 bordeaux mixture applied at 100 to 125 gallons per acre is recommended.

U. S. GOVERNMENT PRINTING OFFICE: 1944

For sale by the Superintendent of Documents, U. S. Government Printing Office
Washington 25, D. C. - Price 10 cents